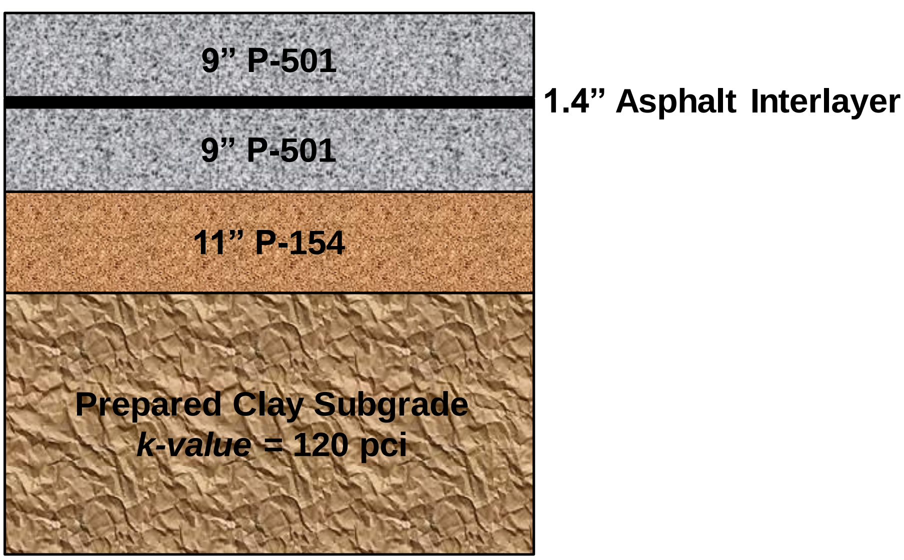
1. INTRODUCTION

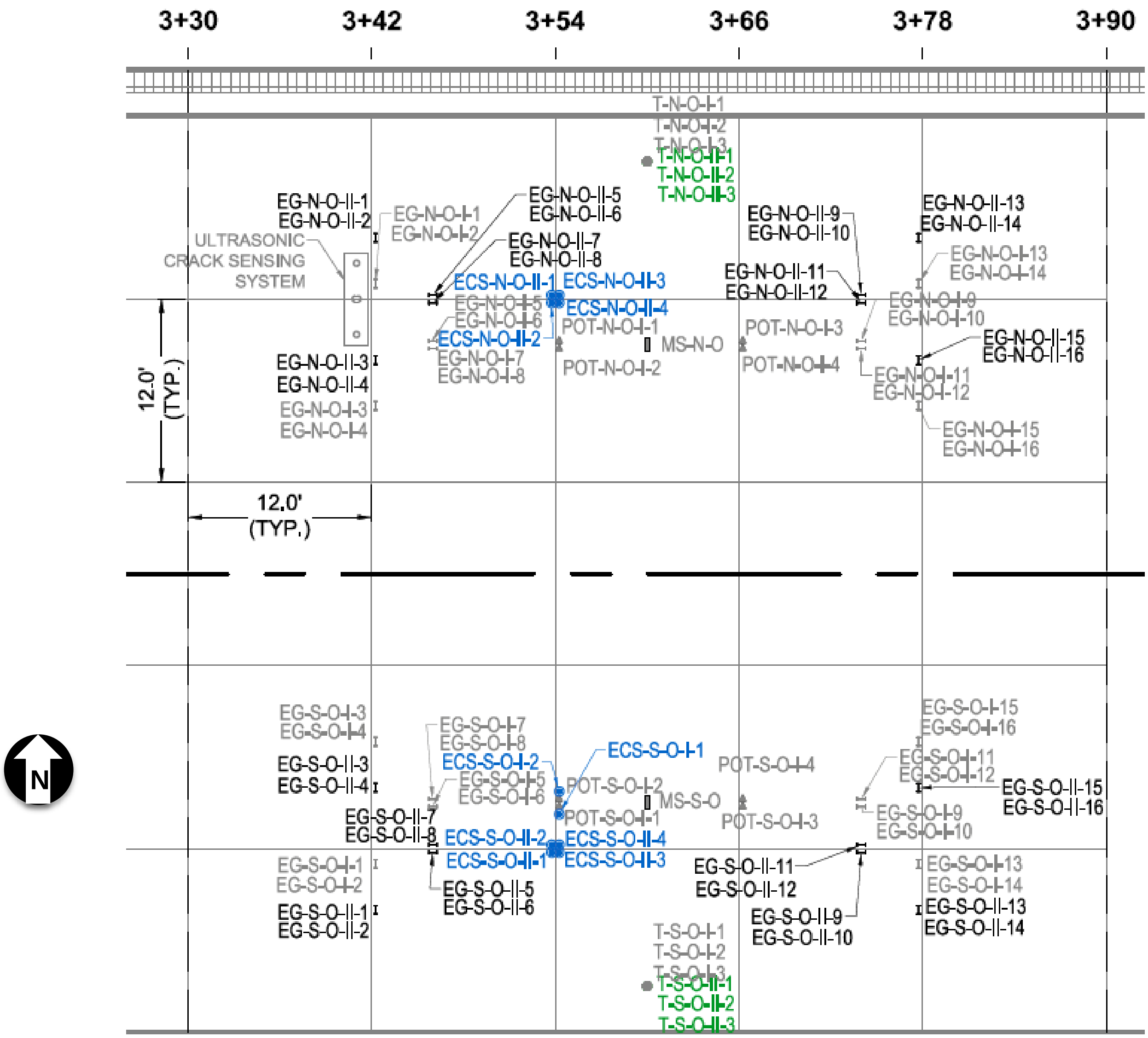
CC8 Overlay Test Area involved two-phase load test experiments. Phase I referred to as Overload Test, involved full-scale construction and instrumentation of an aggregate base and an underlay Portland cement concrete pavement. Phase II, referred to as Unbonded Overlay Test, entailed the construction of a new asphalt interlayer and overlay slab atop post-test Phase I test pavement. The Overload Test experiment was aimed at evaluating ICAO overload criteria for airfield rigid pavements. The concept of conducting the two full-scale experiments in series also provided a realistic way to introduce load-induced damage to the underlying slab for the second experiment. The Unbonded Overlay Test experiment was designed to utilize the distressed remaining underlay slabs to examine the effects of underlay condition on overlay performance and therefore better understand the performance of unbonded concrete overlays on airfield pavements, and to evaluate/improve the use of the structural condition index (SCI) in the design of such pavements.

2. TEST PAVEMENT

Overlay Test Pavement is 60 foot long and 60 foot wide between Station 3+30 and 3+90. Figure 1a shows the pavement is composed of two 9 inch thick unbounded P-501 concrete layers placed on 11 inches of P-154 granular subbase that is supported on prepared clay subgrade with a CBR value of 7 to 8. A 1.2 inch thick asphalt layer is sandwiched between the overlay and underlay as a bond breaker. The design flexural strength (*R*) of the P-501 concrete mix was 650 psi. The test pavement structure is shown below. The subgrade *k-value* was obtained from the field plate load test. Figure 1b shows the plan view of test pavement, indicating that each test item (north and south) has two 12-ft wide lanes, with a 12-ft transition slab between the test items.



a) Profile view

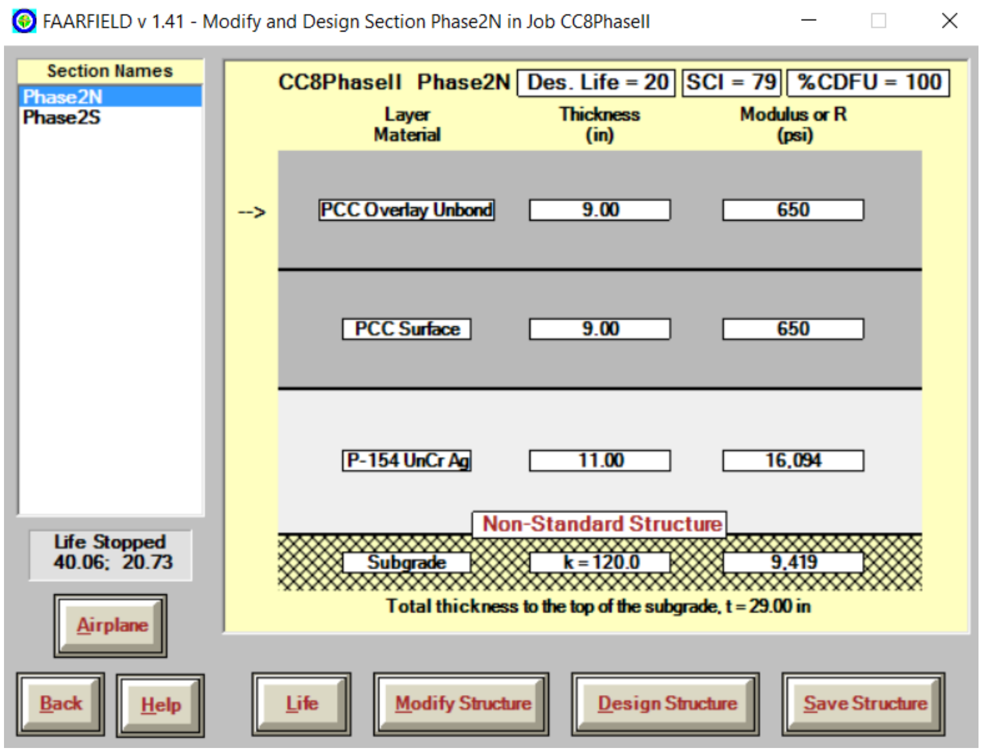


(b) Plan view

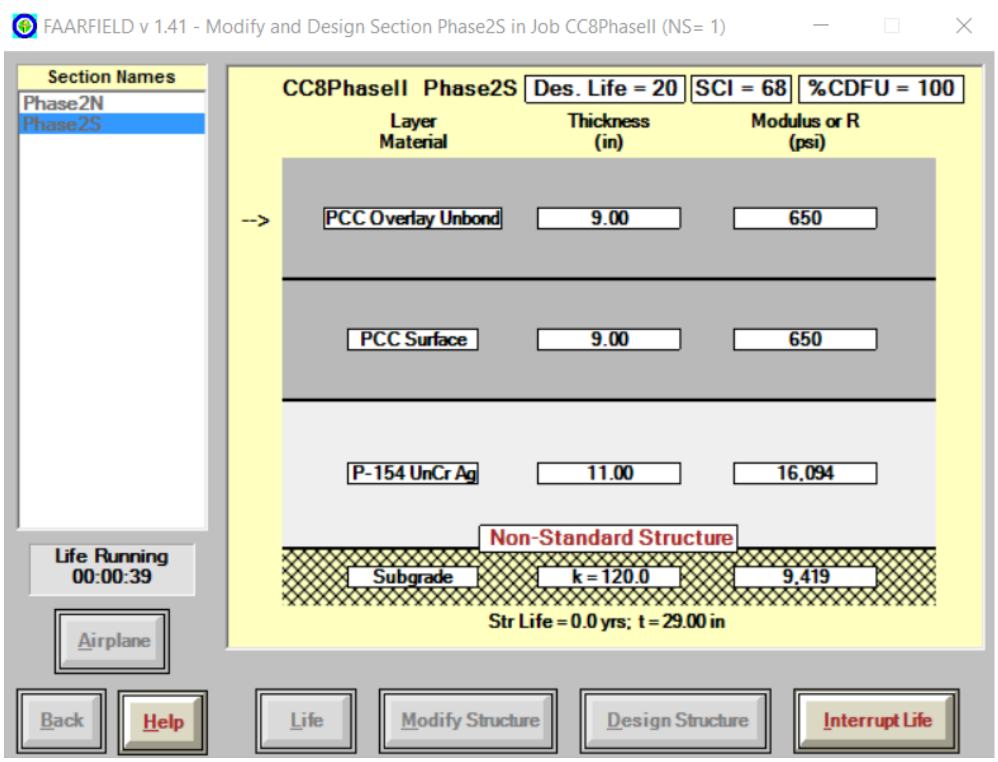
Figure 1. Test Pavement Structure.

3. ESTIMATION OF INITIAL WHEEL LOAD

FAARFIELD 1.41.0112 was used to analyze the as-built pavement structure with a broad range of wheel loads until failure (corresponds to SCI = 80) was reached. SCI values of the existing concrete layer were calculated from the last distress survey conducted upon the completion of Phase I traffic test. As shown in Figure 2, the north test item was loaded with the triple dual tandem (3D), and the south test item was loaded with the twin dual tandem (2D). These gear configurations are consistent with the previous CC4 experiment and are illustrated in Figure 3. It should be pointed out that FAARFIELD does not consider any structural contribution from the asphalt interlayer in the design of an unbonded overlay.



(a) North test item



(b) South test item

Figure 2. FAARFIELD 1.41.0112 Comparative Life Computations.

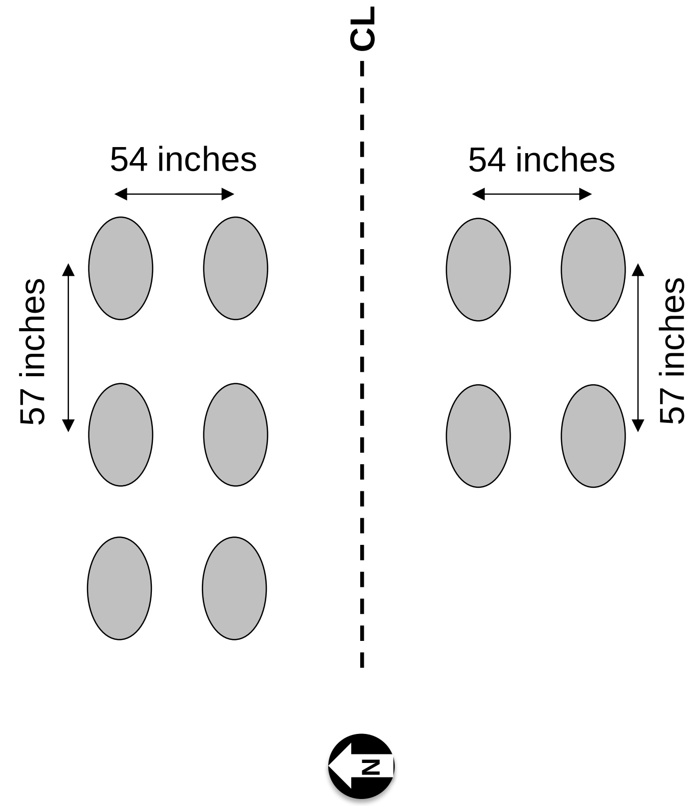


Figure 3. 3D and 2D Gear Configurations.

The wheel load must be carefully selected to avoid confounding of data analysis due to mixed traffic of future increases in load level. Assume NAPTF Test Vehicle @ tire pressure 220 psi and 1,200 annual departures. FAARFIELD runs were first conducted using the design R = 650 psi and then repeated with the 28-day laboratory derived R = 550 psi. For the triple dual tandem (3D), the maximum stresses of both overlay and underlay occurred at the interior of slab. For the twin dual tandem (2D), the interior stresses were dominant in the overlay but almost identical to the edge stresses in the underlay. A summary of FAARFIELD predictions at different wheel loadings is given in Tables 1 and 2 for the north and south test item, respectively. Since all Phase II dynamic sensors were installed either along longitudinal or transverse joints (see Figure 1), only edge stresses in the overlay are reported here. These stresses and calculated life are plotted in Figure 4. There are several observations that can be made:

- The north item loaded with the triple dual tandem consistently required less passes to failure (SCI=80) than the south item loaded with the twin dual tandem at the same wheel load. This reinforces the knowledge that gross aircraft weight is one of the most important factors in airfield pavement performance.
- When compared on the basis of the same wheel load, the performance (passes to failure) were clearly differentiated by the concrete strength, with higher strength (i.e., design R) corresponding to longer life.

- When compared on the basis of the same wheel load, the triple dual tandem always resulted in much higher stresses on the slab surface while the twin dual tandem only slightly increased the stresses at the slab bottom.
- According to FAARFIELD calculations, top-down cracking would be most unlikely to occur regardless of the gear configuration.

Because PCC continues to gain strength over time, the flexural strength of the beams cast during concrete placement and cured in field conditions is expected to be somewhere between 550 and 650 psi prior to Phase II traffic test. Therefore, field R will most likely result in a predicted life between the solid and dashed black lines on Figure 4.

Given that the FAARFIELD design model contains a number of conservative assumptions (fully unbonded slab-base interface, infinite subgrade depth) that may not be reflected in the built structure, figure 4 suggests 35,000 lbs wheel load as the initial wheel load for both north and south test items for a target life of 1000 passes. This initial wheel load corresponds to an approximate stress-ratio of 0.7 with respect to the 28-day laboratory derived R.

4. TEST PROCEDURE

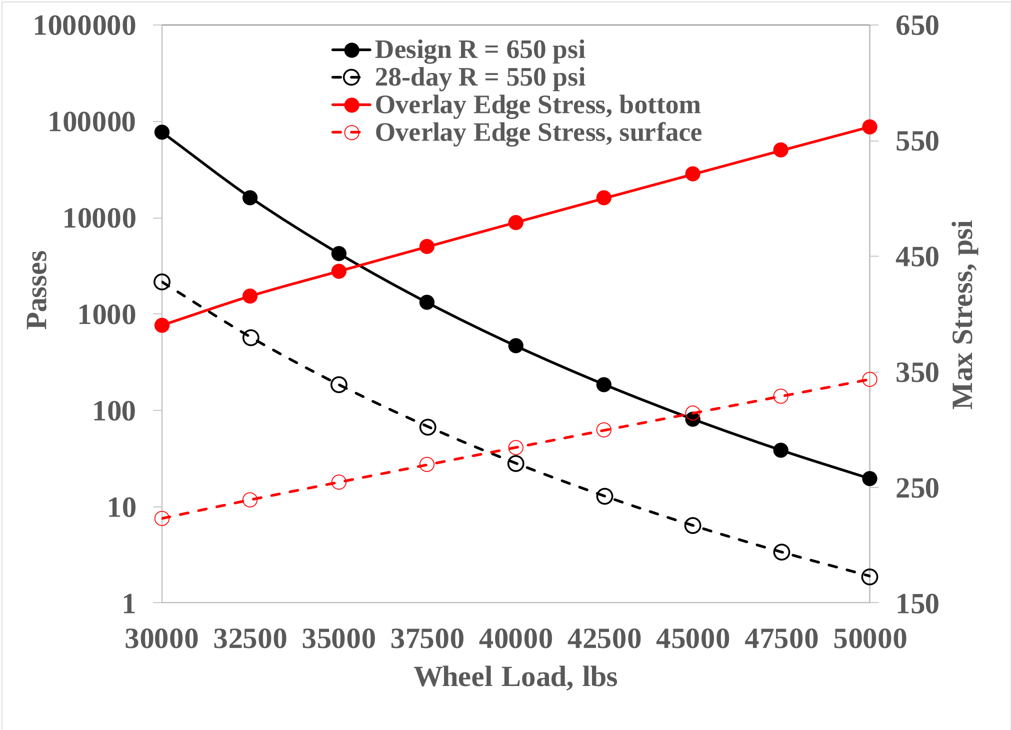
a. General. All traffic will be at 2.5 mph vehicle speed with nominal tire pressure 220 psi.
b. Wander Pattern. The wander pattern consists of 66 passes (Table A1), with each passage of the NAPTV to the east being counted as a pass, and the return to the west counting as a second pass. These 66 passes are arranged in 9 wheel tracks, as summarized in Table A2 and Figure A1. For Track 0, the outside tire of each dual aligns with the longitudinal joint centered within each test item (see Figure A1).
c. Slab Identification. All slabs shall be labelled as demonstrated in Figure A1.
d. HWD Location. Mark HWD test locations at the center of all 12’x12’ slabs and slab corners where ECS deflection sensors were installed. In addition, joint load transfer shall be evaluated at the transverse joint of STA 3+42, 3+54, 3+66, and 3+78.
e. Flexural Strength. Prior to traffic test, flexural strength test ASTM C78 shall be conducted on the beams cast during concrete placement and field cured. FAARFIELD shall then be re-run with field R values to obtain more realistic maximum slab stresses.
f. Seating Loads. Traffic the test pavement (Table A3) using a two-wheel (dual) gear at a load of 10,000 pounds per wheel. Monitor slab vertical movements using ECS deflection sensors and note any effects of seating loads.
g. Baseline HWD and PSPA. The baseline HWD and PSPA measurements will be used to backcalculate layer moduli, monitor slab curling, and changes of support conditions. After seating, perform HWD tests at locations specified in (d). The HWD testing will be conducted with a four-drop loading sequence beginning with an approximate 12,000 lb seating load. The subsequent loads were approximately 4,000 lbs, 8,000 lbs, and 12,000 lbs. All PSPA measurements shall be collected from slab centers.

Table 1. FAARFIELD Predictions for the North Test Item (3D).

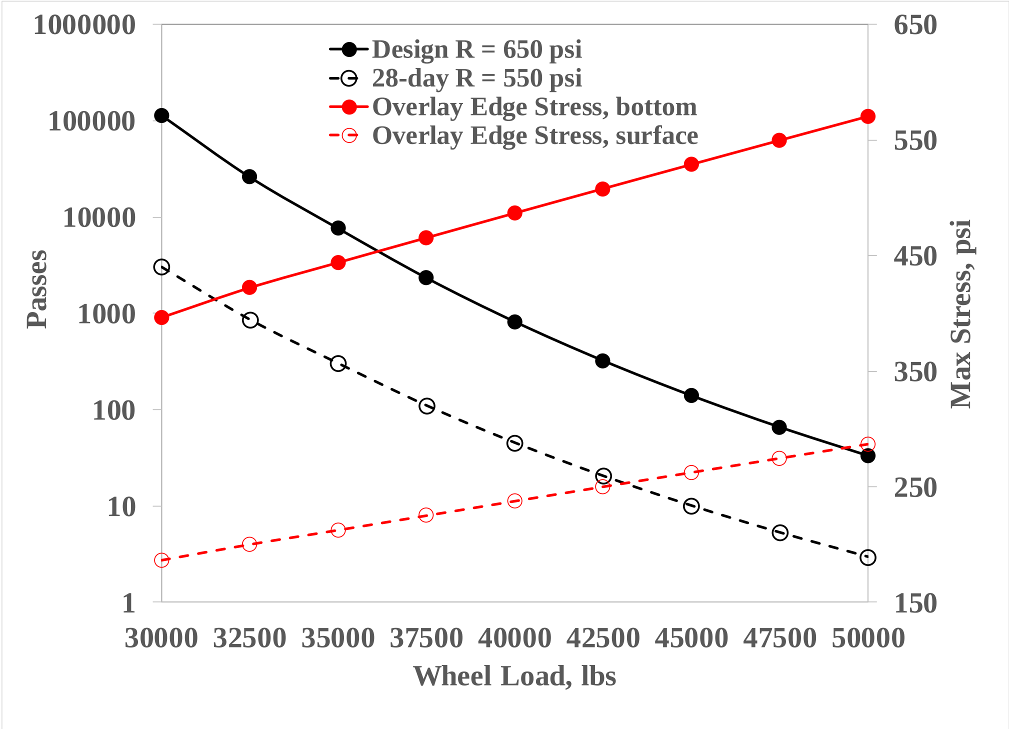
Gear	Wheel Load, lbs	Pass/Coverage	Max Stress, psi		Design R=650 psi		28-day R=550 psi	
			Overlay Edge		Passes	Coverage	Passes	Coverage
			Bottom	Surface				
3D	30000	5.44	390.3	223.0	77419	14231	2164	398
	32500	5.23	415.6	239.2	16216	3101	579	111
	35000	5.04	437.2	254.5	4255	844	185	37
	37500	4.87	458.4	269.6	1317	270	68	14
	40000	4.71	479.5	284.7	468	99	28	6
	42500	4.57	500.4	299.6	186	41	13	3
	45000	4.44	521.1	314.5	82	18	6	1
	47500	4.32	541.8	329.2	39	9	3	1
	50000	4.22	562.3	343.9	20	5	2	0.5

Table 2. FAARFIELD Predictions for the South Test Item (2D).

Gear	Wheel Load, lbs	Pass/Coverage	Max Stress, psi		Design R=650 psi		28-day R=550 psi	
			Overlay Edge					
			Bottom	Surface	Passes	Coverage	Passes	Coverage
2D	30000	5.44	396.5	186.5	114286	21008	3050	561
	32500	5.23	422.2	200.2	26087	4988	867	166
	35000	5.04	444.0	212.6	7643	1517	304	60
	37500	4.87	465.4	225.1	2339	480	111	23
	40000	4.71	486.7	237.6	821	174	46	10
	42500	4.57	507.9	250.1	323	71	21	5
	45000	4.44	528.8	262.4	140	32	10	2
	47500	4.32	549.7	274.7	66	15	5	1
	50000	4.22	570.4	287.0	33	8	3	0.7



(a) North test item



(b) South test item

Figure 4. FAARFIELD Predictions.

h. Ramp-up Response Test with full wander pattern. The purpose of this test is to make sure all systems are operating properly, and to assist in making the final decision about the wheel load to be used for the traffic test. Use 3D gear for the north test item and 2D gear for the south test item.
    1) Traffic 1 wander (66 passes) for both north and south at the same wheel load, 35,000 lbs. Check to verify test items are not damaged. Record baseline sensor readings for both Phase I and II dynamic sensors. Note that during Phase II testing, Phase I dynamic sensor responses shall be continuously collected and analyzed to monitor the deterioration of underlay concrete slabs.
    2) For both north and south test items, identify critical tracks of maximum strain gage responses for Phase II embedded strain gages only.
    3) For both north and south test items, extrapolate the extreme fiber strains based on gage locations from (2), estimate both slab top and bottom stress, and then compare these stresses to field flexural strength and FAARFIELD calculations.
    4) For both north and south test items, increase wheel load in 2,500 lbs increments, traffic critical tracks for both directions (W→E and E→W), and repeat step 3 until both of following conditions are satisfied:
        - maximum slab top / bottom stress = 90% of field R
        - average slab top / bottom stress = 80% of field R

i. Traffic Test. Traffic the north test item using 3D gear and the south test item using 2D gear at the same wheel loading determined from (h). Continue trafficking until a single digit SCI condition is achieved on both sides. If a single digit SCI is attained on either test item, stop trafficking on that item, but continue trafficking on the other test item until SCI below 10.

5. MONITORING

a. Dynamic Responses. Embedded strain gage (EG) and Eddy Current sensor (ECS) data will be collected through the SPUs. During traffic test, the TenView program will be utilized directly to monitor responses indicating rupture at gage locations. For subsequent data analysis, raw data files will be processed with TenView and stored.

b. Static Responses. The temperature and moisture data, which are entirely static (not load-dependent), will be collected hourly to monitor environmental changes.

c. Pavement Condition.
    1) Manual Distress Survey. Distress survey should be conducted on a daily basis for all 12x12' slabs except for the center lane. However, test pavement should be observed informally after each wander and appearance of any distresses noted. In accordance to ASTM D5340, longitudinal, transverse and diagonal cracking; corner breaks; intersecting cracks and shattered slabs; and shrinkage cracking will be considered. As needed, the surveys will be augmented with wire brushes, chalk markings, flashlights and other tools to ascertain the presence and pattern of very fine cracks. Cumulative plots of crack mapping should be prepared. On these plots, the distresses should be color-coded to separate dates/passes of distress survey on which new distresses are observed.

2) SCI Calculation. After each distress survey, pavement inspections should be updated in the PAVEAIR database and a structural condition index (SCI) should be calculated.
3) HWD and PSPA testing should be conducted on a weekly basis.

6. DATA STORAGE

a. Static Data: \\NAPTF\naptf\Static
b. Dynamic Data and Daily Notes: \\NAPTF\naptf\Trafficking

APPENDIX A—SUMMARY OF WANDER PATTERN

Table A1. Carriage positions for each pass for 1 full wander.

Pass Sequence No.	Direction	Track No.	Carriage Centerline Location, ft.	
			North	South
1	W→E	-4	-18.662	11.838
2	E→W	-4	-18.662	11.838
3	W→E	-2	-16.956	13.544
4	E→W	-2	-16.956	13.544
5	W→E	0	-15.250	15.250
6	E→W	0	-15.250	15.250
7	W→E	2	-13.544	16.956
8	E→W	2	-13.544	16.956
9	W→E	4	-11.838	18.662
10	E→W	4	-11.838	18.662
11	W→E	3	-12.691	17.809
12	E→W	3	-12.691	17.809
13	W→E	1	-14.397	16.103
14	E→W	1	-14.397	16.103
15	W→E	-1	-16.103	14.397
16	E→W	-1	-16.103	14.397
17	W→E	-3	-17.809	12.691
18	E→W	-3	-17.809	12.691
19	W→E	-4	-18.662	11.838
20	E→W	-4	-18.662	11.838
21	W→E	-2	-16.956	13.544
22	E→W	-2	-16.956	13.544
23	W→E	0	-15.250	15.250
24	E→W	0	-15.250	15.250
25	W→E	2	-13.544	16.956
26	E→W	2	-13.544	16.956
27	W→E	4	-11.838	18.662
28	E→W	4	-11.838	18.662
29	W→E	3	-12.691	17.809
30	E→W	3	-12.691	17.809
31	W→E	1	-14.397	16.103
32	E→W	1	-14.397	16.103
33	W→E	-1	-16.103	14.397
34	E→W	-1	-16.103	14.397

35	W→E	-3	-17.809	12.691
36	E→W	-3	-17.809	12.691
37	W→E	3	-12.691	17.809
38	E→W	3	-12.691	17.809
39	W→E	1	-14.397	16.103
40	E→W	1	-14.397	16.103
41	W→E	-1	-16.103	14.397
42	E→W	-1	-16.103	14.397
43	W→E	-3	-17.809	12.691
44	E→W	-3	-17.809	12.691
45	W→E	-2	-16.956	13.544
46	E→W	-2	-16.956	13.544
47	W→E	0	-15.250	15.250
48	E→W	0	-15.250	15.250
49	W→E	2	-13.544	16.956
50	E→W	2	-13.544	16.956
51	W→E	-2	-16.956	13.544
52	E→W	-2	-16.956	13.544
53	W→E	0	-15.250	15.250
54	E→W	0	-15.250	15.250
55	W→E	2	-13.544	16.956
56	E→W	2	-13.544	16.956
57	W→E	1	-14.397	16.103
58	E→W	1	-14.397	16.103
59	W→E	-1	-16.103	14.397
60	E→W	-1	-16.103	14.397
61	W→E	1	-14.397	16.103
62	E→W	1	-14.397	16.103
63	W→E	-1	-16.103	14.397
64	E→W	-1	-16.103	14.397
65	W→E	0	-15.250	15.250
66	E→W	0	-15.250	15.250

Table A2. Carriage positions for each track.

Track No.	Carriage Centerline Location, ft	
	North	South
-4	-18.662	11.838
-3	-17.809	12.691
-2	-16.956	13.544
-1	-16.103	14.397
0	-15.250	15.250
1	-14.397	16.103
2	-13.544	16.956
3	-12.691	17.809
4	-11.838	18.662

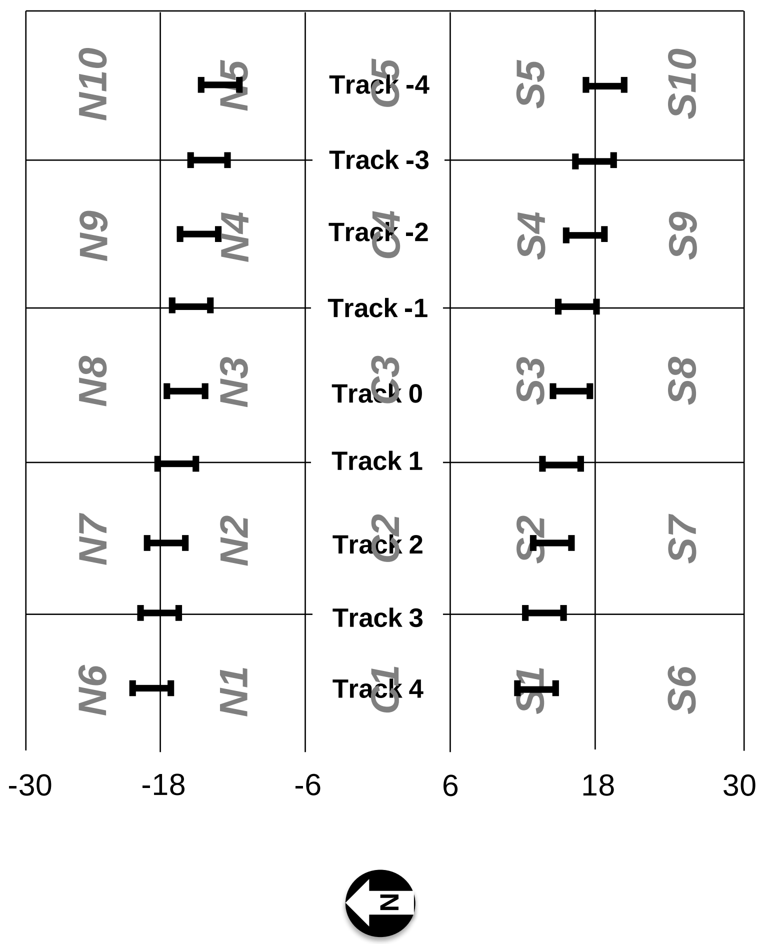


Figure A1. Track position and slab identification.

Table A3. Carriage positions for each pass for seating loads.

Pass Sequence No.	Direction	Track No.	Carriage Centerline Location, ft.	
			North	South
1	W→E	-4	-21.662	14.838
2	E→W	-4	-21.662	14.838
3	W→E	-2	-19.956	16.544
4	E→W	-2	-19.956	16.544
5	W→E	0	-18.250	18.250
6	E→W	0	-18.250	18.250
7	W→E	2	-16.544	19.956
8	E→W	2	-16.544	19.956
9	W→E	4	-14.838	21.662
10	E→W	4	-14.838	21.662
11	W→E	3	-15.691	20.809
12	E→W	3	-15.691	20.809
13	W→E	1	-17.397	19.103
14	E→W	1	-17.397	19.103
15	W→E	-1	-19.103	17.397
16	E→W	-1	-19.103	17.397
17	W→E	-3	-20.809	15.691
18	E→W	-3	-20.809	15.691
19	W→E	-4	-21.662	14.838
20	E→W	-4	-21.662	14.838
21	W→E	-2	-19.956	16.544
22	E→W	-2	-19.956	16.544
23	W→E	0	-18.250	18.250
24	E→W	0	-18.250	18.250
25	W→E	2	-16.544	19.956
26	E→W	2	-16.544	19.956
27	W→E	4	-14.838	21.662
28	E→W	4	-14.838	21.662
29	W→E	3	-15.691	20.809
30	E→W	3	-15.691	20.809
31	W→E	1	-17.397	19.103
32	E→W	1	-17.397	19.103
33	W→E	-1	-19.103	17.397
34	E→W	-1	-19.103	17.397
35	W→E	-3	-20.809	15.691
36	E→W	-3	-20.809	15.691

37	W→E	3	-15.691	20.809
38	E→W	3	-15.691	20.809
39	W→E	1	-17.397	19.103
40	E→W	1	-17.397	19.103
41	W→E	-1	-19.103	17.397
42	E→W	-1	-19.103	17.397
43	W→E	-3	-20.809	15.691
44	E→W	-3	-20.809	15.691
45	W→E	-2	-19.956	16.544
46	E→W	-2	-19.956	16.544
47	W→E	0	-18.250	18.250
48	E→W	0	-18.250	18.250
49	W→E	2	-16.544	19.956
50	E→W	2	-16.544	19.956
51	W→E	-2	-19.956	16.544
52	E→W	-2	-19.956	16.544
53	W→E	0	-18.250	18.250
54	E→W	0	-18.250	18.250
55	W→E	2	-16.544	19.956
56	E→W	2	-16.544	19.956
57	W→E	1	-17.397	19.103
58	E→W	1	-17.397	19.103
59	W→E	-1	-19.103	17.397
60	E→W	-1	-19.103	17.397
61	W→E	1	-17.397	19.103
62	E→W	1	-17.397	19.103
63	W→E	-1	-19.103	17.397
64	E→W	-1	-19.103	17.397
65	W→E	0	-18.250	18.250
66	E→W	0	-18.250	18.250